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Frimodt-Møller, Søren R.; Grund, Cynthia M.; Jensen, Kristoffer

Published in:
Second International ICST Conference on Arts and Technology

Publication date:
2011

Document Version
Accepteret manuscript, peer-review version

From Network to Research – Ten Years of Music Informatics, Performance and Aesthetics

Søren R. Frimodt-Møller[1], Cynthia M. Grund[1] and Kristoffer Jensen[2]

Nordic Network for the Integration of Music Informatics, Performance and Aesthetics
([1])University of Southern Denmark, [2])Aalborg University Esbjerg)
soren@frimodt-moller.dk, cmgrund@ifpr.sdu.dk,
krist@create.aau.dk

Abstract. This article briefly chronicles the history of the Nordic Network of Music Informatics, Performance and Aesthetics (NNIMIPA) and its roots in previous research networks and milieus. It explains how a cross-disciplinary network works and gives rise to research projects that bridge the gap between the disciplines involved. As examples, three thematically linked projects within NNIMIPA are presented. These projects all have performance interaction (between musicians and between musician and audience) as their nexus.

Keywords: Music Informatics, Music Performance, Aesthetics, Philosophy, Interaction, Logical Models, Game Theory, Decision Theory, UML, Gesture, Motion Capture, Research Network

1 Introduction

Research projects which have artistic endeavor as their area of examination will typically require cooperation between different disciplines: If, for example, investigators are interested in the expressive power of a painting, this may lead them to consult not only theorists of art, but also with practitioners - in this case, the painters themselves – as well as with curators, museum-goers etc. For the members of the Nordic Network for the Integration of Music Informatics, Performance and Aesthetics (NNIMIPA), which has its origins in local research networks and milieus dating back to 2001 (see section 2 below), cross-disciplinarity has been a given condition from the start. A prominent field in current music research is the development of models for how we interact with music (whether as listeners or as performers). Such research calls upon the insights of, among others, musicians, composers, musicologists, philosophers and computer scientists (the latter sometimes with the development of specific products in mind). NNIMIPA has from the start tried to combine the insights of the various disciplines and professions dealing with music performance in order to develop a better foundation for discussing questions related to how we interact with music. In the following, some of the research conducted within NNIMIPA will be presented in order to show how the cross-disciplinary nature of a network can benefit the specific research projects of individual researchers.

Section 2 contains a history of the network, while section 3 and its subsections consider three different aspects of performance interaction: The expressive means a musician has at his disposal via his gestures when interacting with an audience (3.1), ways of modeling interaction between musicians during rehearsals and performances when these are recorded on video (3.2), and formal schemes (borrowing methods from epistemic logic, game theory and decision theory) for describing the cognitive

background of the decisions made by musicians during the process of coordination in the performance (3.3).

2 The History of NNIMIPA

The driving motivation behind the establishment of NNIMIPA has been to explore the voltage field that is created when music informatics, performance and areas traditionally dealt with by philosophical aesthetics interact. It complements and supplements two Danish networks devoted to interdisciplinary studies involving music – NTSMB – Netværk for Tværvidenskabelige Studier af Musik og Betydning/ Network for Cross-Disciplinary Studies of Music and Meaning (www.ntsmb.dk, established in 2001 with funding from the Danish Research Council for the Humanities) and *The Aesthetics of Music and Sound: Cross-Disciplinary Interplay between the Humanities, Technology and Musical Practice*, a research program based at the University of Southern Denmark as part of the Institute of Philosophy, Education and the Study of Religions since 2006 (www.soundmusicresearch.org). In addition, many NNIMIPA members are active as contributors, peer reviewers and members of the editorial board and/or staff of *JMM: The Journal of Music and Meaning*, www.musicandmeaning.net, an international, peer-reviewed online journal. *JMM* was founded in 2003 as an outgrowth of the activities within NTSMB.

NNIMIPA was officially established during the 2007-2008 academic year, when funding provided by the University of Southern Denmark at Odense was matched by Nordplus in order to establish this Nordic cooperative initiative. The charter members were (1) University of Southern Denmark; (2) Academy of Music and Music Communication, Esbjerg, Denmark, as of 1/1-2010 renamed Academy of Music and Dramatic Arts, Southern Denmark after merging with the Carl Nielsen Academy of Music, Odense and The School of Dramatic Arts Odense; (3) Aalborg University Esbjerg; (4) University of Tampere, Finland; (5) Sibelius Academy, Helsinki; and (6) Royal Institute of Technology, Stockholm, Sweden. Nordplus continued to provide funding for NNIMIPA activities held during the 2008-2009 and 2009-2010 academic years in the form of grants which were matched by the participating institutions. The University of Oslo became a member in 2009. NNIMIPA became a research network under NordForsk (www.nordforsk.org) on September 1, 2010, with funding during 2010-2013. In 2010 Bifröst University, Iceland, and University of Iceland, Reykjavik, Iceland came on board, as well as Malmö Academy of Music, Lund University, Sweden, and Grieg Academy, Bergen University College, Norway. The decision to award the grant was made by the director of NordForsk following an evaluation carried out by a panel of independent experts.

The educational, lecture and research activities are documented through the website www.nnimipa.org which was launched in February 2010.

3 Research

The following three subsections present some of the research projects conducted within NNIMIPA. All of them have performance interaction (whether between musicians or between musician and audience) as their nexus.

3.1 Music, Meaning and Movement

One area of investigation that engages all who are active within NNIMIPA is that which deals with the ways in which music may be regarded as meaningful.

A low-tech approach to the exploration of the relationship between music, meaning and movement took center stage together with a high-tech motion capture approach during the NNIMIPA coordination meeting held at The University of Oslo, February 18-19, 2010. William Westney, Paul Whitfield Horn Professor of Piano, Browning Artist-in-Residence School of Music, Texas Tech University demonstrated techniques he has been developing for over 25 years in order to encourage musicians to find ways of keeping their playing (or singing) fresh and invested with personal engagement.

Westney's workshop is known as *The Un-Master Class* (UMC) [1] and was originally intended to address the problem that many musicians, despite high levels of training, deliver performances that come across as rather lifeless and generic. While it still functions in this way, it has become increasingly apparent that the presuppositions behind the UMC raise deep questions involving the locus of meaning in music and what the character of this meaning might be.

Westney's work is thus of key interest to Cynthia M. Grund, Associate Professor of Philosophy, Institute of Philosophy, Education and the Study of Religions (IFPR) University of Southern Denmark (SDU) at Odense, Project Manager for NNIMIPA, and Editor-in-Chief for *JMM: The Journal of Music and Meaning*. The two have embarked upon an extensive research cooperation, which became woven into the fabric of NNIMIPA when Westney was named Hans Christian Andersen Guest Professorial Fellow at IFPR-SDU for a six-month period during the 2009-2010 academic year. Grund and Westney write:

> One of the signature features of the UMC is the innovative integration of the audience within its pedagogical and aesthetic framework, which is constructed in stepwise, interactive fashion during the first hour of the two-hour session. All participants listen to instructions about the forthcoming "warm-up," during which audience and performers will be on equal footing as they participate in carefully constructed and sequenced exercises. The warm-up is designed to create a specific experiential context for the second hour, when instrumental and vocal musicians will offer live performances.
>
> The exercises consist largely of expressive, gestural activities. Their conceptual basis owes much to the seminal theories of Emile Jaques-Dalcroze, to which Westney was introduced as a child. Later, as a university professor and performer, Westney revisited the Dalcroze approach to education with a specific question in mind: how to teach rhythm in a more integrated and effective way in the studio. After reacquainting himself with the work of Dalcroze as an adult, however, Westney began to develop new ways in which similar techniques could be applied in broader contexts involving authenticity in interpretation and the performer-audience dynamic ([2] pp. 34-35).

An important part of Westney's approach thus involves movement and gesture, which function as non-verbal embodied vehicles for capturing and remembering nuances of interpretation and performance. This emphasis dovetailed in a very relevant fashion with the high-tech approaches being developed and employed in the fourMs laboratory by, among others, Professor Rolf Inge Godøy and postdoctoral researcher Alexander Refsum Jensenius. These approaches employ a complete state-of-the-art Qualisys motion capture system. This consists of a nine-camera Oqus 300 system, a

MEGA ME6000 Wireless EMG and a 200 fps grayscale Point Grey camera. Data can be streamed in real time through OSC-protocol via UDP/IP to MAX/MSP/Jitter software and synchronized through a MOTU time piece allowing synchronous playback of analog, motion, video and audio data [3] ,[4]. (For those interested in this type of research, Rolf Inge Godøy and Marc Leman, professor at the University of Ghent, present a body of work on the implications of an array of IT-approaches to the study of the connections between sound, movement and meaning in [5], as does Alexander Refsum Jensenius in [6].)

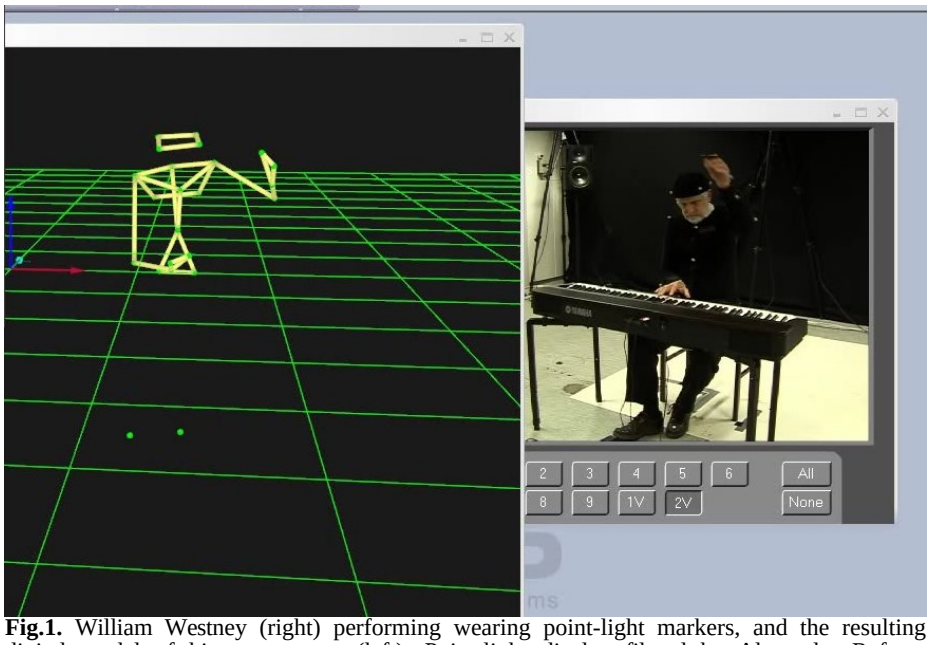

Fig.1. William Westney (right) performing wearing point-light markers, and the resulting digital model of his movements (left). Point-light display filmed by Alexander Refsum Jensenius and Ståle A. Skogstad at the FourM's Lab, UiO, Oslo, Norway. Filmclip rendered and sound-and-video synchronized by Kristian Nymoen. Still photo from [7].

Grund produced an online multimedia document [7] assisted by and with input from Alexander Jensenius, Kristian Nymoen, Ståle A. Skogstad and William Westney in order to provide some perspectives on where an approach combining state-of-the-art IT, concerns attendant to issues of live performance and concerns from philosophical aesthetics might lead. Grund and Westney are also looking forward to exploring the investigative possibilities afforded by markerless motion capture in the study of movement as it relates to musical meaning, and they are still analyzing the implications of the data provided by the February 2010 Oslo session, aided by Josué Moreno and Dāvis Ozoliņš, who through their affiliations with the Sibelius Academy have had occasion to attend courses offered by NNIMIPA at the Master's level (see www.nnimipa.org) and to do NNIMIPA-funded work at the fourMs laboratory.

3.2 Models of Interaction

One of the aspects of the interaction of musicians that is important within the NNIMIPA network is how musicians communicate during performance. Three different modes of communication may occur: *verbal*, i.e. when musicians talk to each other; *non-verbal*, e.g. when musicians nod, smile etc. at each other, and *musical*, i.e. when the musicians give each other signs via their instrumental sound production. It is assumed that musicians act in a manner similar to the belief-desire-intention paradigm of Bratman [8], in which beliefs and desires combine to form intentions. Of course, decisions and planning steps must be included if a full model is to be described, but these steps are usually not externalized to a level where they can be observed. Only the individual musician can know the exact nature of her own belief-desire-intention process, but musicians may obtain knowledge about the belief-desire-intention processes of other musicians via information gathered in the interaction process, i.e. by observing the other players.

Several experiments have been performed by Kristoffer Jensen, Associate Professor, Department of Architecture, Design and Media Technology, Aalborg University Esbjerg, in order to observe and describe the interaction between musicians. One important conclusion has been made from the initial observations: at the level of professional performance, a performance of music based on notation (scores, parts etc.) contains very little visible communication. Therefore, subsequent observations have been made in connection with either improvised music, in collaboration with guitarist Fredrik Søgaard during his improvisation classes at the conservatory in Esbjerg, or with the rehearsals of amateur musicians.

Unified Modeling Language (UML) [9] is used in the field of object-oriented software engineering. UML diagrams are graphic notations of systems, and many different diagrams exist. In the case of interacting musicians, *Use Cases* model the dependencies between the musicians and their goals. *Use Cases* can be further developed to *State Machine Diagrams*, and *Class Diagrams*, if the goal is to implement the system, but for observation and modeling studies, however, the *Sequence Diagram* is of particular interest. In the *Sequence Diagram*, the vertical lines correspond to each musician or other agent, and the arrows correspond to the messages between the musicians and other agents, and the arrows correspond to the messages between the musicians.

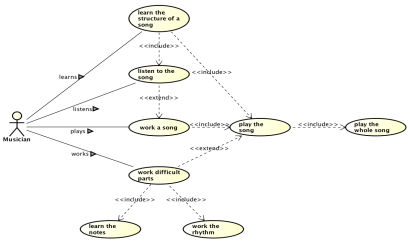

Fig.2. *Use Case* of a musician learning to play music.

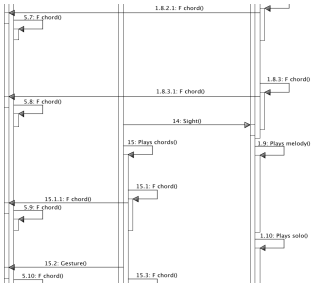

Fig. 3. *Sequence Diagram* of musicians in a rehearsal (detail).

In fig.2 an example of a *Use Case* is shown, in which the musician rehearses a song alone, and in fig. 3 a detail of a *Sequence Diagram* is shown in which three musicians rehearse a jazz tune. A UML diagram is useful and easy to access, as many software systems exist for this purpose, and software students and engineers often have knowledge about UML and may gain further experience through the modeling of musicians interacting through UML. It is clear that the information obtained through

UML modeling can be used to corroborate the formal logic models described below in section 3.3. For instance, in the *Sequence Diagram*, the decision as to who will play the next solo can be observed. This is done either through verbal communication or through unilateral decision by one musician.

3.3 Formal Models for Decision Processes in the Performance

As stated at the beginning of 3.2, the interaction between musicians during a performance is not only dependent on verbal and non-verbal signalling between musicians, but also on the 'signs' communicated via the music being performed by the individual musicians. A large part of this communication process rests on whether or not the other musicians actually receive the 'message' inherent in another musician's phrasing. This means that the interaction process is dependent on the individual musician's ability to interpret the situation in a way that will promote coordination. As part of his PhD dissertation [10], Søren R. Frimodt-Møller, Managing Editor of *JMM: The Journal of Music and Meaning*, has discussed how performing musicians make decisions not only as a result of their individual intentions for the performance, but also as a result of their assumptions regarding the intentions of the other performers, and of how they conceive of the norms inherent in the performance context at hand. In order to describe these decision processes, Frimodt-Møller has considered three different yet associated modeling schemes which will be briefly described in the following.

1) Coordination based on *common knowledge*: Common knowledge of some fact p in a group of people G involves not only that everyone in G knows that p, but also that everyone in G (potentially) knows that everyone in G knows that p, that everyone in G knows that everyone in G (potentially) knows that everyone in G knows that p and so on ad infinitum. Common knowledge as described by e.g. Fagin et al ([11], 9) is typically approximated following a situation where p is a public announcement to G. In the music ensemble, a type of information that might attain the status of common knowledge is that consisting of the agreements that are verbalized (and thus made 'public') during the rehearsals. Should a coordination problem occur, that is, should the musicians suddenly not be synchronized in accordance with their initial plan for the performance, the musicians will by default try to follow the general strategies they consider to be common knowledge in the ensemble, based on how they remember the rehearsals. Using classical epistemic logic as a modeling tool, it can be shown that in situations where common knowledge in G of p, notated C_Gp, has not been established before the performance, C_Gp is actually unattainable during a performance due to the unreliable nature of non-verbal communication and symbolic communication through the music itself.

2) Game Theory with Variable Frames: In situations where common knowledge of anything is unattainable, musicians may still be able to make decisions when facing a coordination problem, if they consider how their co-players are most likely to act in the situation at hand. In the branch of game theory developed by Bacharach et al [12] called *variable frame theory*, coordination games (e.g. where two people who are not allowed to communicate will get the highest pay off when simultaneously choosing the same alternative when a choice of several alternativess is possible) are described

as a reasoning process where one considers how the opponent 'frames' or, in other words, categorizes the different options at hand, and thereby how likely she is to consider particular choices more 'salient' than others. The more the participating players know about each other in advance, the more accurate their expectations for each others' choices will be. This seems to be paralleled by the fact that musicians often are more comfortable playing with musicians whom they already know well.

3) Decision Theory with Intentions: As has been mentioned in 3.2 above, intentions play an important role in a musician's decision-making process. Olivier Roy [13] has discussed - with regard to decisions in general - the role a person's intentions play in the formation of plans. Transferred to the domain of music performance, the general idea is that in a given situation, the musician can choose to follow a strategy in line with a strategy profile (a combination of strategies, one for each musician in the ensemble) chosen from a limited set of possible strategy profiles. The musician chooses a strategy profile that has one or more possible outcomes that she intends to achieve. If the musician has reason to believe that the other musicians are not following the same strategy profile, she will have to search for a new profile that is in accordance with what she considers to be the possible intentions of the other musicians, but *ceteris paribus* still in accordance with her own intentions. What the formal model based on these ideas shows is that if we disregard the possibility of unintended actions, the musicians should gradually better their chances of coordination with each new step of searching for a new profile (as they will be able to rule out certain strategy profiles at each step).

The general point of exploring the formal models above is to highlight the importance of following rules during the performance and especially the importance of remaining sensitive to the actions of the other players. In short, this research project provides a set of formal descriptive tools to capture some of the intuitive insights regarding interaction that performers already possess Combined with the insights gained through Kristoffer Jensen's research described in 3.2, this project may be a step towards a comprehensive understanding of performance interaction in general.

4 Conclusions and Further Perspectives

NNIMIPA has, as the title of this paper suggests, indeed moved from being a research network in the sense of a group of researchers networking (e.g. meeting and discussing their products) to being a research network in the sense of a network that works together to conduct research. Grund and Westney's philosophical and practice-based approaches to the investigation of music, meaning and movement have been enriched by the insights gained thanks to the pioneering work of Godøy and Jensenius and the group at the fourM's laboratory at the University of Oslo augmented by the NNIMIPA-funded assistance of Moreno and Ozoli š. The collaborations between Jensen and Frimodt-Møller concerning the interaction process of performing musicians may similarly lead to an extended platform for discussing matters related to musical interaction.

In the future, NNIMIPA members will continue to explore not only interpersonal interaction within the setting provided by music performance, but also the interaction between musician, listener and environment, or, more broadly speaking, context. The various ways in which the specific context (encompassing physical as well as social and cultural aspects) of the performance affects the audience's experience and the

immediate decisions of the musician, provides a rich field of theoretical problems that necessitate further collaboration between performing musicians and researchers in music philosophy and technology.

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